Chien-Chang Hsu*: **A study on Formosan *Panicum* (Gramineae), with special reference to their lodicules**

許 建 昌*: 台湾産キビ属（イネ科），特にその鱗被について

East Asiatic species of *Panicum* are well represented in Formosa in spite of rather small area. Twelve species, including a new record (*Panicum cambogiense*), are now known from the district. The members of the millet genus are one of the most common grasses in the Island. They abound from coasts to plains at low altitudes where the rainfall is well distributed through the year round and the winter temperature is not too low.

This is a taxonomic account of the Formosan species mainly based upon the specimens deposited in the Herbarium of Botanical Institute, University of Tokyo. A key to the species is presented and some notes together with brief enumerations are given under each species. A table showing the characters such as chromosome numbers, florets, spikelets, and lodicules is presented (Tab. 1) instead of full description. In addition to the classical characters of the spikelets, a special attention is paid on lodicules, one of the true floral parts which is accepted as perianth remains. Because of small and inconspicuous figures they were overlooked, and in ordinary descriptions there was none or only a few words regarding the lodicules.

After the researches of Hubbard (1946) and Church (1949), Stebbins (1956 a, b) suggested the importance of the lodicules in systematics. This view was further advanced by Reeder & Ellington (1960), Stebbins & Crampton (1961) and Tateoka (1960, 1962 a, b). However, limited members of festucoid grasses representing some genera of a few tribes have hitherto been examined. Yet no information was given for the specific rank in a genus or even for a tribe belonging to so-called "natural" panicoid grasses.

On the degrees of fleshness, plicature (fig. 15) and vascularization, the lodicules of east Asiatic species of *Panicum* are in serial modification. They are two in number, truncate at the apex and narrowed at the base. They increase their complexity gradually from a transparent thin segment with three short veins to a moderately fleshy structure with numerous veins (figs. 1-14). The

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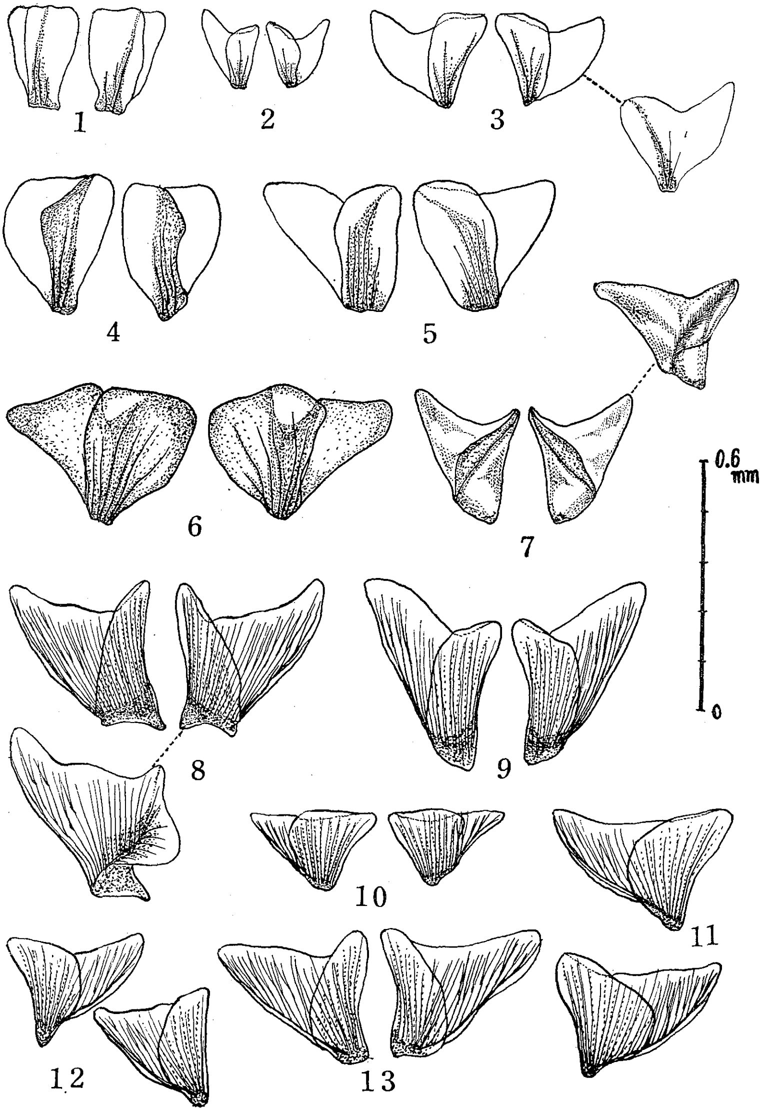

Figs. 1–13. Lodicules of east Asiatic species of *Panicum*. 1. *P. bisulcatum* Thunb. 2. *P. trichoides* Sw. (found in southern China, but not in Formosa). 3. *P. brevifolium* L. 4. *P. notatum* Retz. 5. *P. incomtum* Trin. 6. *P. maximum* Jacq. 7. *P. repens* L. 8. *P. paludosum* Roxb. 9. *P. dichotomiflorum* Michaux (naturalized in Japan, originally from N. America). 10. *P. austro-asiaticum* Ohwi. 11. *P. trypheron* Schult. 12. *P. cambogiense* Balansa. 13. *P. psilopodium* Trin.

nature of the lodicules is so correlated with others, especially with the shape of the cross-section of the upper florets, that it seems to be of sufficient diagnostic value to provide a solution to the classification of the genus (Tab. 1).

The writer is grateful to Prof. H. Hara for his kind directions and warm regards. Thanks are also due to Dr. T. Yamazaki and Dr. T. Tateoka for their constructive criticisms of the manuscript. To my colleague, Mr. C. C. Chen of Academia Sinica, I am deeply indepted for his encouragements and informations.

Key to the species

1. Upper florets ridged, triangular in cross-section; lodicules thin and transparent, 3-7-veined:
 2. Leaves linear ....P. *bisulcatum*
 2. Leaves ovate to linear-lanceolate:
  3. Grasses with weak, usually decumbent culms; blades thin:
   4. Blades narrowed at base; first glume 1/2 as long as the spikelet .... *P. trichoides*1)
   4. Blades amplexicaular; first glume as long as the spikelet......*P. brevifolium*
  3. Grasses with wire-like struggling culms; blades hard in touch:
   4. Blades ciliate at margin; lower palea absent ....*P. notatum*
   4. Blades not ciliate at margin; lower palea as long as the spikelet .... *P. incomtum*
1. Upper florets plano-convex or lentiform in cross-section; lodicules thicker, numerous-veined:
 2. Upper florets transversely rugose; cultivated tall grass ....*P. maximum*
 2. Upper florets not transversely rugose:
  3. Aquatic or on moist soils; first glume truncate, 1/5 as long as the spikelet; upper florets nearly plano-convex in cross-section:
   4. Spikelets about 3.5 mm long:
    5. Lower palea present; rhizomatous; culms hard ....*P. repens*
    5. Lower palea absent; not rhizomatous; culms spongy.........*P. paludosum*
   4. Spikelets about 2.1 mm long.................................*P. dichotomiflorum*1)

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1) Not found in Formosa, but reported from east Asia.

Tab. 1. Characters for checking Formosan species of *Panicum*.

Species	chromosome number (2n)	x-section of upper floret	length of spikelet	I. glume/spikelet	number of veins			lower palea/upper floret	lodicules		
					I. gl.	II. gl.	III. gl.		no. of vein	nature	size (μ)
1. *bisulcatum*	36	T	2.0	1/3–1/2	1–3	5	5	0	3	TR	260×190
2. *trichoides**		T	1.2	1/2	1–3	5	5	3/5	3	TR	200×150
3. *brevifolium*	36	T	1.5	1/1	3	5	5	1/1	3	TR	280×220
4. *notatum*	36	T	2.0	1/1	3–5	5	5	0	5	TR	350×260
5. *incomtum*	36	T	2.1	4/5	3–5	5	5	1/1	5–7	TR	320×350
6. *maximum*	32	PR	2.8	2/5	3–5	5	5	1/1	7–9	F	300×380
7. *repens*	45	P	3.5	1/5	0	7–9	7–9	1/1	0	MT	300×240
8. *paludosum*	54	P	3.5	1/5	0	7–9	7–9	0	N	MT	480×500
9. *dichotomiflorum**		P	2.1	1/5	3	5	5	1/1	N	MT	480×350
10. *austro-asiaticum*		L	1.5	2/3	3–5	7	5	1/1	NN	MF	200×300
11. *trypheron*		L	4.0	1/2–2/3	3–5	7–9	7	2/3	NN	MF	300×450
12. *cambogiense*		L	2.1	1/3	5–7	7–9	9–11	1/1	NN	MF	260×320
13. *psilopodium*	36	L	2.4	1/3	5–7	9–11	11–13	1/1	NN	MF	300×380
14. *miliaceum*	36	L	4.0	1/2–2/3	5–7	11–13	11	1/2	NN	MF	480×700

T=triangular in cross-section of the upper floret; P=plano-convex in cross-section of the upper floret; R=transversely rugose; L=lentiform in cross-section of the upper floret; N=less numerous; NN=numerous, with a basal vein which produces much divided secondary veins (fig. 14); TR=transparent; F=fleshy in texture; MF=moderately fleshy in texture; MT=moderately thick in texture; III. gl. =lower lemma.

* Not found in Formosa, but reported from east Asia.

3. Not aquatic; first glume more than 1/3 as long as the spikelet; upper florets lentiform in cross-section:
  4. Spikelets usually reddish purple, about 1.5 mm long...*P. austro-asiaticum*
  4. Spikelets more than 2 mm long:
    5. Plant not covered with tubercle-based hairs ....*P. psilopodium*
    5. Plant covered with tubercle-based hairs:
      6. Vein of glumes and lower lemmas anastomosing ....*P. cambogiense*
      6. Vein of glumes and lower lemmas not anastomosing:
        7. Lower lemmas 7-veined; not cultivated ....*P. trypheron*
        7. Lower lemmas 11-veined; cultivated..............................*P. miliaceum*

1. **Panicum austro-asiaticum** Ohwi in Act. Phyt. Geob. **11**: 45 (1942); Jansen in Reinwardtia **2**: 314 (1953); Keng, Fl. Ill. Sinicarum Gram. 658 (1959); Bor, Grass. India etc. 324 (1960).

P. humile Nees ex Steud., Syn. Pl. Glum. **1**: 84 (1854), non Trin., Gram. Panic. 164 (1826).

P. muscarium sensu Honda in Bot. Mag. Tokyo **38**: 59 (1924) et Monogr. 250 (1930).

P. vescum R. R. Stewart in Brittonia **5**: 452 (1945).

This is a dwarf to medium sized sun-loving grass. It is dwarf when it grows on rather dried grasslands, and gets taller in moist grounds. The spikelets are usually reddish-purple in color. The lodicules are finely numerous-veined, about 0.2 mm in length by 0.3 mm in width and usually moderately fleshy (fig. 10). Found here and there in the Island.

Distributed in India, Indo-China, Malaysia, southern China to Formosa and also in tropical Africa.

2. **Panicum bisulcatum** Thunb. in Nov. Act. Soc. Upsal. **7**: 141 (1815); Ohwi in Act. Phyt. Geob. **11**; 45 (1942); Jansen in Reinwardtia **2**; 314 (1953); Keng, Fl. Ill. Sinicarum Gram. 657 (1959); Bor, Grass. India etc. 324 (1960).

This is one of the most common grasses growing on moist soils. The size of the spikelets varies rather in a wide range. They are much small in the young stages. The lodicules are three-veined, about 0.26 mm in length, by 0.19 mm in width. They are transparent and obscurely two-folded (fig. 1). On the nature and vascularization of the lodicules, this species is closely related to *P.*

trichoides and *P. brevifolium*. Extremely thin and transparent nature of the lodicules producing weak 1–3–veins distinguishes this species from the others.

Distributed in India, Indo-China, the Philippines, Formosa, China to Japan, extending to Micronesia and Australia.

3. **Panicum brevifolium** Linn., Sp. Pl. ed. I, 59 (1753); Ohwi in Act. Phyt. Geob. **11**: 45 (1942); Jansen in Reinwardtia **2**: 315 (1953); Keng, Fl. Ill. Sinicarum Gram. 655 (1959); Bor, Grass. India etc. 324 (1960).

Var. *hirtifolium* (Ridl.) Jansen was separated by its long-hairy blades and peduncles of the panicle. In our specimens they are subglabrous. The species is found in moist shady situations at low altitudes. Amplexicaul and ovate-lanceolate blades, and gibbose spikelets are the outstanding characteristics of the species. The lodicules are three-veined, about 0.28 mm in lenght by 0.22 mm in width, partially folded, thin and transparent (fig. 3).

Distributed in India, Indo-China, Malaysia, southern China, Formosa, extending to Africa.

4. **Panicum cambogiense** Balansa in Morot. J. de Bot. **4**: 142 (1890); Reeder in J. Arn. Arb. **29**: 268 (1948); Keng, Fl. Ill. Sinicarum Gram. 657 (1959); Bor, Grass. India etc. 325 (1960).

P. caesium Nees in J. Bot. Kew Misc. **2**: 97 (1850), non Nees (1836).

P. reticulatum Thwaites in Trimen, J. Bot. **23**: 271 (1885).

P. cruciabile Chase in J. Arn. Arb. **20**: 309 (1939).

This is a new record to the grass flora of Formosa. Collected by Y. Shimada and Y. Yamamoto in mountainous regions. It resembles *Panicum miliaceum* and *P. trypheron* in having tuberculate-hispid sheaths, but anastomosing veins of the glumes and lower lemmas distinguish this species at once. Full discussion on the epithet was made by Henrard in Blumea **3**: 444 (1940). The lodicules are finely numerous-veined, about 0.26 mm in length by 0.32 mm in width, and usually they are moderately fleshy (fig. 12).

Hab.: Karang vunoue, 18. V. 1939, Yamamato, Y. 718 (TI); Shen-swei (深水), Kaoshung Co., 20, VIII. 1940, Shimada, Y. (TI).

Distributed in Ceylon, Indo-China, Malaysia, southern China, Formosa.

5. **Panicum incomtum** Trin., Gram. Panic. 200 (1826); Ohwi in Act. Phyt. Geob. **11**: 45 (1942); Keng, Fl. Ill. Sinicarum Gram. 650 (1959); Bor, Grass. India etc. 326 (1960).

P. sarmentosum sensu Hook. f., Fl. Brit. Ind. **7**: 54 (1897); etiam Honda, Monogr. 251 (1930).

P. submontanum Hay., Mat. Fl. Formos. 402 (1911) et Icon. Pl. Formos. **7**: 64 (1918).

This is a polymorphic species, originally described from the Philippines. It has been much confused with true *Panicum sarmentosum* Roxb. But they are different in habit of panicles, veins and relative length of the glumes, i.e. elliptic outline of panicle with viscid branches and strongly veined first glumes of the three-quarters of the length of the spikelets in *P. incomtum*; open panicles with smooth branches and shinning not strongly veined first glumes of half the length of the spikelets in *P. sarmentosum*. Chase (in J. Arn. Arb. **20**: 311. 1939) and Blake (in Proc. Roy. Soc. Queensl. **59**: 158. 1948) separated the two species, but Reeder (in J. Arb. **29**: 271. 1948), followed by Jansan (in Reinwardtia **2**: 318. 1958), considered them as one species. In our specimens the first glumes are 2/3 to 4/5 as long as the spikelets, and the glumes and lower lemmas are strongly veined. The branches are viscid and the panicles are globose or ellipsoidal in outline. In my investigation, no true *P. sarmentosum* is found in Formosan materials. The lodicules are 5–7–veined, about 0.32 mm in length by 0.35 mm in width, partially folded, thin and transparent (fig. 5).

Distributed in India, Indo-China, the Philippines, southern China, Formosa.

6. **Panicum maximum** Jacq., Collect. Bot. **1**: 76 (1786); Ohwi in Act. Phyt. Geob. **11**: 46 (1942); Keng, Fl. Ill. Sinicarum Gram. 650 (1959); Bor, Grass. India etc. 327 (1960).

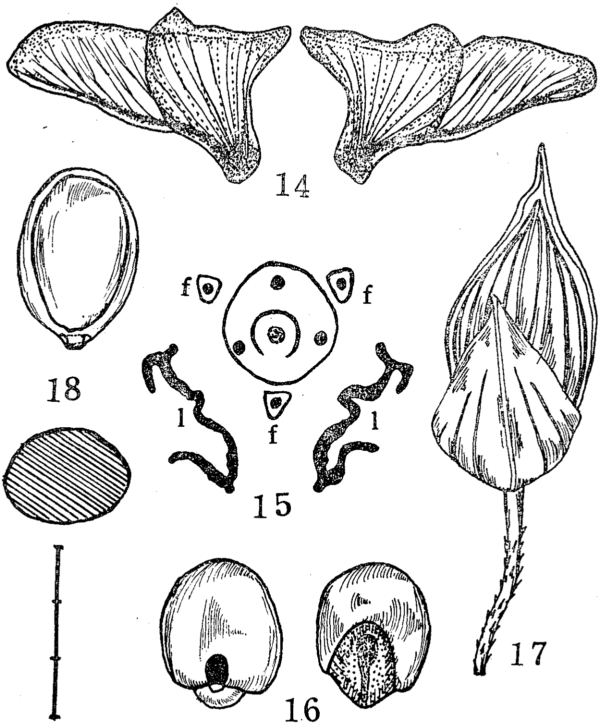
This tall grass is cultivated for pasture and as green manure. It also grows on waste hillsides as an escaped and naturalized grass throughout the Island. The perennial habit and transversely rugosed upper lemmas are the outstanding chararcteristics of the species.

The lodicules are 3–5–veined, about 0.30 mm in length by 0.38 mm in width, partially thick folded, and very flesy in texture. Judging from the outstanding nature of the upper lemmas and lodicules, it is reasonable to separate this group as a subgenus *Megathrsus* (=subgen. *Eupanicum*, sect. Maxima) as Pilger (in Nat. Pflanzenf. ed. 2, 14e. 1940) did.

7. **Panicum miliaceum** Linn., Sp. Pl. ed. 1, 58 (1753); Hay., Icon., Pl. Formos. **7**: 64 (1918); Honda, Monogr. 248 (1930); Ohwi in Act. Phyt. Geob. **11**:

46 (1942); Chipp. in Grass. Past. S. Afr. 327 (1955); Keng, Fl. Ill. Sinicarum Gram. 657 (1959); Bor, Grass. India etc. 327 (1960).

Broomcorn millet is cultivated as a cereal to a limited extent by Mountain Tribes of Formosa. The lodicules are relatively well developed in the genus. They are numerous-veined with a basal vein subdividing into secondary veins, about 0.48 mm in length by 0.70 mm in width and moderately fleshy (figs. 14, 15). *P. miliaceum*, *P. psilopodium*, *P. cambogiense*, *P. trypheron* and *P. austro-asiaticum* are accepted to be a compact group. The members of this group are characterized by lentiform cross-section of the upper florets. The moderately



Figs. 14-18. *Panicum miliaceum*. 14. Lodicules. 15. Cross-section of a flower, showing the position and plicature of the lodicules. 16. Caryopsis. 17. A spikelet. 18. Upper floret and its cross-section.
1=lodicule. f=filament. Scale: 14-15: 0.12 mm./unit; 16-18: 0.77 mm./unit.

fleshy lodicules are broadened, with a basal vein mentioned above. The first glumes are the same texture as the lower lemma and more than 1/3 as long as the spikelet.

8. **Panicum notatum** Retz., Obs. Bot. **4**: 18 (1786); Bor, Grass. India etc. 701 (1960).

P. montanum Roxb., Fl. Ind. **1**: 315 (1820); Jansen in Reinwardtia **2**: 316 (1953); Bor, Grass. India etc. 329 (1960).

P. cordatum Büse in Miq. Pl. Junghum 376 (1854); Ohwi in Act. Phyt. Geob. **11**: 45 (1942); Keng, Fl. Ill. Sinicarum Gram. 649 (1959).

After checked on the type, Bor proposed to abandon the name *P. montanum* due to the presence of the earlier name, *P. notatum* Retz. This species is very similar to *P. incomtum* in habitat, shape of leaves and spikelets, but is distinguished from the former by its tubercle-based cilia decorating the cordate blade-bases and well developed lower palea. They have linear-lanceolate leaves and the culms are hardened, usually growing among the bushes along clearing or forest margins. The lodicules are 5-veined, about 0.35 mm in length by 0.26 mm in width and partially folded, thin and transparent (fig. 4). This species is closely related to *P. incomtum* not only in nature of the spikelets but also in lodicules. The lodicules are still thin and transparent as the *P. bisulcatum*-group but the number of veins and size are increased.

9. **Panicum paludosum** Roxb., Fl. Ind. **1**: 310 (1820); Ohwi in Act. Phyt. Geob. **11**: 47 (1942); Reeder in J. Arn. Arb. **29**: 268 (1948); Keng, Fl. Ill. Sinicarum Gram. 652 (1959); Bor, Grass. India etc. 329 (1960).

P. proliferum sensu Hook. f., Fl. Brit. Ind. **7**: 50 (1897).

P. decompositum sensu Rendle in J. Linn. Soc. **36**: 330 (1904); Hay., Icon. Pl. Formos. **7**: 63 (1918).

This species is very much confused with *P. repens* Linn. and was said even to be an aquatic form of the latter. *P. paludosum* is different from *P. repens* by its thick spongy and floating culms, distinct veins of the spikelets and by its lanceolate-ovate spikelets. While in *P. repens*, the culms are hard and erect with creeping rhizomes, the veins of the spikelets are obscure, and the spikelets are elliptic-ovate. Furthermore the differences between these two species may be seen in the shape, size and vascular traces of the lodicules. In *P. repens*, they are veinless, about 0.30 mm in length by 0.24 mm in width and winged (fig. 7), whereas in *P. paludosum* they are numerous-veined, about 0.48 mm in length by 0.50 mm in width, and partially folded (fig. 8). *P. paludosum* and *P. dichotomiflorum* are characterized by less numerously veined and moderately thick (not fleshy) lodicules which are elongate and the veins are produced from the base. They have truncate first glume of 1/5 as long as the spikelets and upper florets of plano-convex in cross-section.

Widely distributed and common in tropical Asia extending to Australia.

10. **Panicum psilopodium** Trin., Gram. Panic. 217 (1826); Ohwi in Act. Phyt. Geob. **11**: 46 (1942); Keng, Fl. Ill. Sinicarum Gram. 657 (1959); Bor, Grass. India etc. 329 (1960).

P. trypheron sensu auct. Formosa.

This grass is usually found in rather dry cultivated fields. The elliptical spikelets (about 2.5 mm long) and glabrous plant body distinguish this species from the rest. The lodicules are finely numerous-veined, about 0.30 mm in length by 0.38 mm width, and partially folded, fleshy.

Distributed in India, Ceylon, Malaysia, China and Formosa.

11. **Panicum repens** Linn., Sp. Pl. ed. 2, 87 (1762); Ohwi in Act. Phyt. Geob. **11**: 47 (1942); Keng, Fl. Ill. Sinicarum Gram. 650 (1959); Bor, Grass. India etc, 330 (1960).

This is a very common weed on moist soils throughout the Island. I have never found it producing viable seed. It has very strong rhizomes and grows rapidly by means of vegetative reproduction. From the cytological studies, we (Chen and Hsu, 1961) were convinced that this is a sterile hybrid and we believed that the plant studied by Tateoka in southern Japan (Yakushima) may also the same kind of hybrid.

Distributed in tropics and subtropics of both hemispheres.

12. **Panicum trypheron** Schult. var. **suishaensis** (Hay.) Hsu, comb. nov.

P. suishaensis Hay., Icon. Fl. Formos. **7**: 62 (1918); Jansen in Reinwardtia **2**: 318 (1953).

P. trypheron sensu auct.

This rather rare species was collected from the mountainous regions. In the type specimen of *P. suishaensis* from Formosa, the leaves are erect and the basal ones are numerous and long. The culms are somewhat swallen and protected by basal sheaths. These characters are not seen in Indian specimens of *P. trypheron*. Jansen reported Malaysian species as *P. suishaensis*. It seems to me that his plant is the same as our materials. The plant collected from southern China (Keng, l.c. fig. 591, 1959) seems also to be the same as our specimens.

No satisfactory spikelet is available for lodicule study in this variety. Only Indian material of *P. trypheron* (Tateoka, T. 371) is observed. The lodicules are numerous-veined, about 0.3 mm in length by 0.45 mm in width, partially folded and moderately fleshy.

Distributed in Malaysia, southern China and mountainous regions of Formosa.

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1. 台湾産のキビ属12種について調べることができたので，東亜でよく見る種類をも含めて，特にそれらの鱗被と稔性護穎を観察した。

2. 鱗被は従来花被が残存した物だと考えられていたが，非常に微細なために，系統分類の上では却って小穂の各部が重視され，鱗被はしばしば無視されてきた。

3. キビ属の鱗被は2枚あって，頂端は切形で基部は細まり，薄くて透明かつ脈が織細で短く3〜5本あるものからやや肉質で脈が強く長いものまで色々ある (figs. 1–14)。いずれも程度の差こそあれ fig. 15. の如く摺畳して対をなしている。

4. 稔性小花の横断面には3角形，半円形およびレンズ形があり，ギニアグラスでは横皺紋がついている。これらは鱗被の性質などと相関してキビ属の分類では大きい意味をもっている。

5. 小穂の形状や稔性小花，鱗被の性質などを Tab. 1. に示し，検索表も附加して各種についての記載は省略した。しかし台湾産の種類には主な文献をあげ，ノートを付した。

6. *Panicum cambogiense* Balansa は苞穎および不稔性護穎の脈が網状になる点で他のものと異り，新産地として記録し，台湾のグラスフロラに加えたい。

7. スイシャセトガヤは小穂の形状の上では *P. trypheron* と区別は見られなかった。しかし根生葉が長く，葉鞘は稈の基部を包んで肥大している。*P. trypheron* の変種としてあつかった。

8. ハイキビは種子が見られず，台湾を始め琉球・屋久島のものも含めて雑種であることが伺われる (Chen & Hsu, 1961)。この雑種では鱗被に脈が見られず，fig. 7. の如く翼が出ている。

○ バラ色のヤマゼリ （檜 山 庫 三） Kozo HIYAMA: A new form of *Ostericum Sieboldi* Nakai

ヤマゼリで鮮かな淡紅紫色の花のものがある。これは山梨県北都留郡上野原町鶴島で1962年10月14日に採集したもので，爪部を除けば花弁全体が濃淡のない同一色調で発色しているために特に美しく感じた。セリ科でもオヤブジラミ，ミツバ，オオバセンキュウなどは時に花弁の一部が紅紫色に染まることがあるが色に濃淡があって色変わり品とは認めにくいのが普通である。上記のものを**ハナヤマゼリ**と呼びたい。

Ostericum Sieboldi (Miq.) Nakai forma **roseum** Hiyama, n. f.

Flores rosei. Antherae atropurpureae. Planta tota glabra.

Hab. Hondo: Tsurushima, Uenohara-machi, Prov. Kai (Hiyama & Kobayashi, Oct. 14, 1962—type in Makino Herbarium).

（東京都立大学　牧野標本館）